

REMARKS

Claims 8-13, 15-19, 21, and 28-35 are presented for further examination. Claims 8, 15, 19, and 28 have been amended, and claims 24-27 have been cancelled.

In the final Office Action mailed January 11, 2008, the Examiner finally rejected claims 8-13, 19, and 21 under 35 U.S.C. § 103(a) as obvious over Sparks et al. (5,531,121) in view of Sparks (5,719,069) and further in view of newly-cited U.S. Patent No. 5,393,375 (“MacDonald”). Claims 14-18 and 22-35 were rejected as obvious over Sparks et al. in view of Mirza et al. (5,883,420).

Applicants submitted arguments in the form of a Reply on March 11, 2008, which applicants adopt and incorporate herein in their entirety. The Examiner responded with an Advisory action dated March 26, 2008, asserting that the Reply did not place the application in condition for allowance. In response to the majority of Applicants’ arguments, the Examiner stated, “Applicants point to no evidence in the record to support this assertion.” In addition the Examiner cited cases supporting the use of “implicit” teachings, suggestions, or motivations (also referred to by the Examiner as “hints”) drawn from the references or the art as a whole rather than explicit expressions in the references.

Applicants respectfully disagree with the bases for the rejections and request reconsideration and further examination of the claims.

Informalities in Office Action

There is some confusion in the record as to which of the two Sparks references is being applied as the primary reference. In the final Office Action mailed January 11, 2008, the Examiner appears to have switched the patent numbers in the rejection of claims 8-13, 19, and 21, and to have used the wrong patent number in the rejection of claims “14-18 and 22-25.” However, in the Examiner’s remarks accompanying the rejections, the reference numbers matched the Sparks et al. reference (U.S. Patent No. 5,531,121). For clarity, applicants in this Amendment will use “Sparks et al.” to refer to the ‘121 patent and “Sparks” to refer to the ‘069 patent.

Also for clarity, applicants note that the numbered paragraph “2” [second occurrence] as it appears on page 5 of the final Office Action refers to claim 14, but this claim was cancelled by the applicants in the previous Amendment. Hence, applicants will not address claim 14 in this Amendment.

Claim Informality

In reviewing the Examiner’s mapping of the claims to the cited references, applicants noted that the coating recited in claim 19 is not found in the final structure. The coating is removed during the etching as shown in Figure 27. The recitation of the coating was inserted into claim 19 by the Amendment filed on August 27, 2007, and has now been removed.

Claim Rejections

The Examiner relies upon the additional MacDonald patent in combination with the two Sparks patents to assert it would be obvious to form the structure on a monocrystalline substrate as recited in claims 8-13, 19, and 21. In making this rejection, the Examiner refers to intermediate steps in the primary reference, Sparks et al., which shows various incomplete structures and some complete structures, none of which have all of the claimed features. The Examiner imports these missing features from two other patents, Sparks and MacDonald.

Turning first to the primary reference, Sparks et al. describes a method of bulk micromachining a silicon substrate so that the substrate can then be used to form a variety of structures. Figures 2a-2c illustrate the bulk micromachining process by which open trenches 20 and an open cavity 22 are formed in the silicon substrate 10. The trenches and open cavity can then be used to form devices such as the motion sensing device 25 of Figure 3. Figures 4a – 4c illustrate the formation of a piezoresistor 34 using the bulk micromachining above (see col. 7, lines 66-67). Figure 5 shows an accelerometer mass 32, while Figure 6 shows a pressure sensing membrane 38 formed adjacent the motion sensing device 25. Figure 7 illustrates two pressure sensing membranes 38a, 38b formed on opposing sides of the substrate 10. Figures 8a, 8b show the formation of a capacitor 46, and Figures 9a-9d and 10a-10c demonstrate how the motion

sensing device 25 of Figure 3 can be encapsulated in order to isolate the element 18 and accelerator mass 32 from the environment of the substrate 10.

All of the foregoing devices are formed in an epitaxial layer 14 that is grown on the bulk machined substrate 10. Each of these structures interfaces with or interacts with the cavity through the trenches 20, 20a, 20b. In other words, the trenches 20, 20a, 20b are essential for the purpose of Sparks et al. In all of the embodiments described by Sparks et al., the trenches are filled with polysilicon 36 and the cavity or cavities 22 are lined with the polysilicon.

Applicants note that Sparks et al. show in the embodiments of Figure 7 (opposing pressure sensing membranes) and Figure 10c (motion sensing device) that the trenches and cavity are first lined with oxide (42) and then with a lining of polysilicon 36 formed over the oxide. As such, the presence of the polysilicon over the oxide negates any epitaxial growth inhibition. In other words, the exposed polysilicon layer 36 in the cavity 22 is subject to epitaxial-type growth.

Claim 8 is directed to a structure formed in a substrate of monolithic semiconductor material, the structure comprising at least one trench formed in the substrate having an open top and an open bottom and a coating on the lateral walls of the at least one trench with material resistant to etching, a cavity having walls formed below each of the at least one trench and having an open top in communication with the open bottom of the at least one trench, and a coating on the walls of the cavity with material inhibiting epitaxial growth. Claim 8 further recites an epitaxial layer of semiconductor material formed on the substrate to cover the open top of the at least one trench and epitaxial growth formed in the at least one trench to fill the at least one trench and to encase the cavity in the substrate.

Nowhere does the combination of Sparks et al., Sparks, and MacDonald teach or suggest encasing the cavity in the substrate of semiconductor material with the cavity lined with material inhibiting epitaxial growth. In the final Office Action the Examiner asserted that it would be obvious to combine the teaching of Sparks with the architecture of Sparks et al. and the substrate of MacDonald to obtain the claimed combination. However, while claim 8 as amended is no longer rendered obvious by this combination of references, applicants respectfully submit

that there is no motivation to combine Sparks with Sparks et al. as the Examiner suggests and further with MacDonald.

As discussed above, all of the structures of Sparks et al. require interaction between the trenches and the buried cavity through the polysilicon and the substrate 14 to provide either a resistance, capacitance, or sensing function. Sparks et al.'s stated objective is to form "various types of sensing devices having a wide variety of possible configurations" using its bulk micromachining process (see column 2, lines 43-47). Moreover, Sparks et al. has the objective of suitably sealing the trenches "so as to form membranes for sensing pressure or, alternatively, encapsulated so as to protect the bridge and cantilevered beams" (see column 2, lines 34-36). As such, it is important that the structures formed in the epitaxial layer of Sparks et al. interact with the underlying cavity.

In contrast, claim 8 recites the cavity encased within the substrate of monolithic semiconductor material and lined with a coating of material inhibiting epitaxial growth. The trenches form no functional part of the final structure. Sparks et al. teaches lining the cavity with a coating 36 of polysilicon, which does not inhibit epitaxial growth. Even though the Examiner points to the layer of oxide 42 in two of Sparks et al.'s embodiments, as argued above this layer is covered with the polysilicon 36, thus negating any epitaxial inhibiting characteristics. Combining the teachings of Sparks with Sparks et al. does not overcome this deficiency.

Moreover, Sparks notes in his background that the method of Sparks et al. has the objective of forming a device on a same substrate as an integrated circuit to be used to process signals, at that Sparks et al. fails to teach or provide a method by which they can be fabricated concurrently. Sparks therefore fills this need by providing a method that significantly reduces the number of processing steps in order to form concurrently the integrated circuits and the sensors on the same device.

In addition to simultaneous sensor and circuit formation in the epitaxial layer, Sparks also specifically describes bonding the substrate 18 to a glass or silicon wafer 20 such that a cavity 22 formed in the substrate 18 forms a chamber beneath the sensing membrane of the pressure sensor 10 (see column 4, lines 47-51). This clearly speaks away from a monolithic semiconductor material substrate. While the Examiner recognizes this, the Examiner asserts that

column 5, lines 35-40 and column 2, lines 35-50 of Sparks '069 describe the substrate being a "suitable substrate." Applicants have reviewed these cited sections and note that the section of text in column 2 does not refer to "a suitable substrate" and in the cited section in column 5, line 31 refers to "a suitable dopant." Moreover, the Examiner references column 5, lines 15-25 of Sparks et al. '121, which merely refers to "a suitable acceptor concentration" in the substrate 10. Thus, applicants respectfully submit that neither of these references suggest that the cavity be encased in a monolithic semiconductor material.

Moreover, even if one were motivated to refer to the MacDonald et al. reference, U.S. Patent No. 5,393,375, the figures referenced by the Examiner, Figure 2F and Figure 4, do not show a monolithic substrate encasing a cavity. Rather, they merely show an open cavity configuration in which a plurality of arms 82 extend from a base 86 formed out of the same material. Thus, even if one were motivated to combine these references as suggested by the Examiner, applicants respectfully submit that the combination would fail to meet the limitations of claim 8 or any of the claims depending therefrom, *i.e.*, claims 9-13.

Turning next to claim 19, which was rejected on the same grounds as claim 8, claim 19 is directed to a structure formed in a substrate of monolithic semiconductor material that comprises a cavity formed in and surrounded by the monolithic semiconductor material, the monolithic semiconductor material comprising a membrane formed of the monolithic semiconductor material, including epitaxial growth of the semiconductor material on the monolithic semiconductor material, that covers the cavity in the substrate, the membrane having a thickness in the range of between 1 and 3 micrometers.

In view of the substantial amendments to claim 19, applicants respectfully submit that the prior basis for the rejection of claim 19 is now moot. Thus, claim 19 is clearly allowable over the references previously cited and applied by the Examiner, as well as dependent claim 21.

Turning next to independent claim 15, this claim is directed to a monolithic wafer of semiconductor material that comprises a plurality of buried cavities formed in and completely surrounded by the monolithic semiconductor material, with each cavity of the plurality of buried cavities having only one coating on at least one wall thereof consisting of a layer of material inhibiting epitaxial growth.

Claim 15 has been rejected over Sparks et al. in view of Mirza et al. As discussed above, nowhere do Sparks et al. teach or suggest a monolithic semiconductor substrate that completely surrounds a plurality of buried cavities. Also, Sparks et al. do not teach or suggest having only one coating of epitaxial inhibiting growth on the walls of the cavity. The Examiner applies the Mirza et al. reference as teaching such a coating.

Applicants respectfully submit that there is no motivation in either Sparks et al. or Mirza et al. for altering Sparks et al. to use a single layer of material inhibiting epitaxial growth. The Board of Patent Appeals and Interferences has, since the U.S. Supreme Court's KSR Opinion, required Examiners to articulate a sufficient reason why one of skill in the art would modify the primary reference to arrive at the presently claimed subject matter. One reason is to avoid "the unwitting application of hindsight" such as discussed by the Board in *ex parte So and Thomas*, BPAI Appeal No. 2007-3967 (January 4, 2008) in which the Board stated "there is nothing in the applied references which would have motivated an artisan to select this particular ingredient and then use the resulting composition..." (See also *Ex parte Fathman*, BPAI Appeal No. 2007-4156 (December 11, 2007) in which the Board rejected the Examiner's arguments, stating "contrary to the Examiner's intimation, the mere recognition that '[t]he genetic modification of cells has been routine in the art for some twenty plus years' this quote ... does not mean that a person of ordinary skill in the art would willy-nilly modify any cell with any gene to treat a disease." The Board further noted that "the inferences and creative steps derived from the prior art on this record fail to lead a person of ordinary skill in the art to appellants' claimed invention. On this record, the Examiner has failed to identify a viable reason why a person of ordinary skill would have been led to combine the teachings of [the cited art] in the manner set forth in appellant's claimed invention."

In the present case, the particular process taught by Sparks et al. requires that the polysilicon coating be applied over the oxide layer 42. If one were to modify Sparks et al. with the teachings of Sparks, the stated purpose of Sparks et al. would be defeated. For example, at column 10, lines 8-19, Sparks et al. teach that the process of plugging the circular trenches 20a with a polysilicon seal must be done only after an oxide layer 42 is formed on the walls of the circular trenches 20a and on the interior surfaces of the cavities 22. To do otherwise would

result in the cavities completely filling up with polysilicon. A completely filled cavity would defeat the purpose of Sparks et al. Thus, the combination of Sparks et al. with Mirza et al. in which a single layer of oxide would remain in the cavity 22 is untenable in Sparks et al.

Thus, applicants respectfully submit that claim 15 is clearly allowable over the combination of Sparks et al. and Mirza et al.

Independent claims 28 and 32, each directed to a wafer formed of monolithic monocrystalline semiconductor material and having buried cavities surrounded by the monocrystalline material with a single coating formed of epitaxial inhibiting layer in each of the cavities are allowable for the reasons discussed above with respect to claim 15. All claims depending therefrom are also allowable for the features recited therein as well as for the reasons why their respective independent claims are allowable.

In view of the foregoing, applicants respectfully submit that all of the claims remaining in this application are in condition for allowance. In the event the Examiner disagrees or finds minor informalities, the Examiner is urged to contact the undersigned attorney by telephone at (206) 622-4900 in order to expeditiously resolve prosecution of this application.

Consequently, early and favorable action allowing these claims and passing this case to issuance is respectfully solicited.

The Director is authorized to charge any additional fees due by way of this Amendment, or credit any overpayment, to our Deposit Account No. 19-1090.

Respectfully submitted,

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